SQL Server Parallel Data Warehouse Architecture

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Agenda

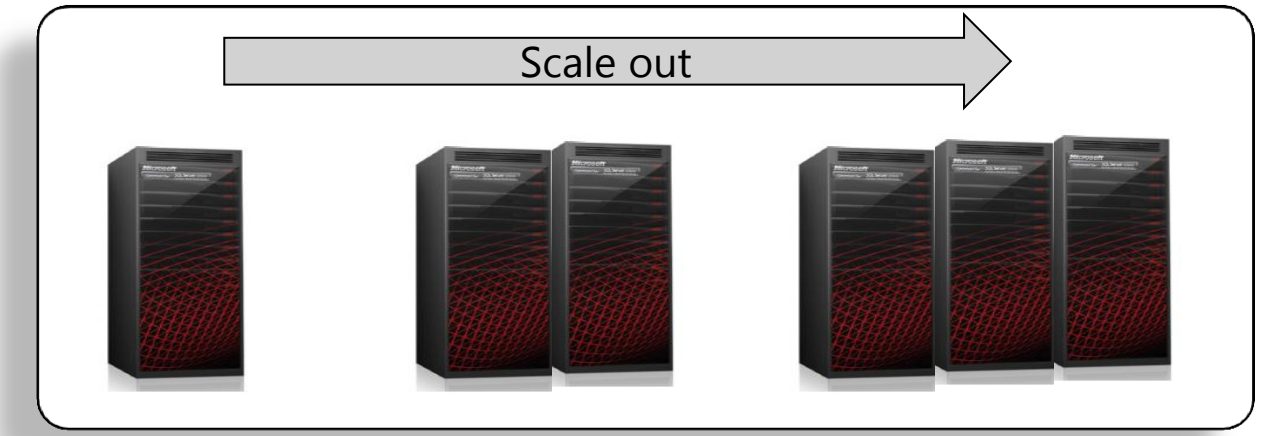
- PDW Fundamentals
  - Scale-out system architecture (HW and SW)
- Core functionality
  - Shell Database and Distributed Query Processing
  - Data Movement
  - Bulk Loading
- Futures

PDW Fundamentals

What is Parallel Data Warehouse?

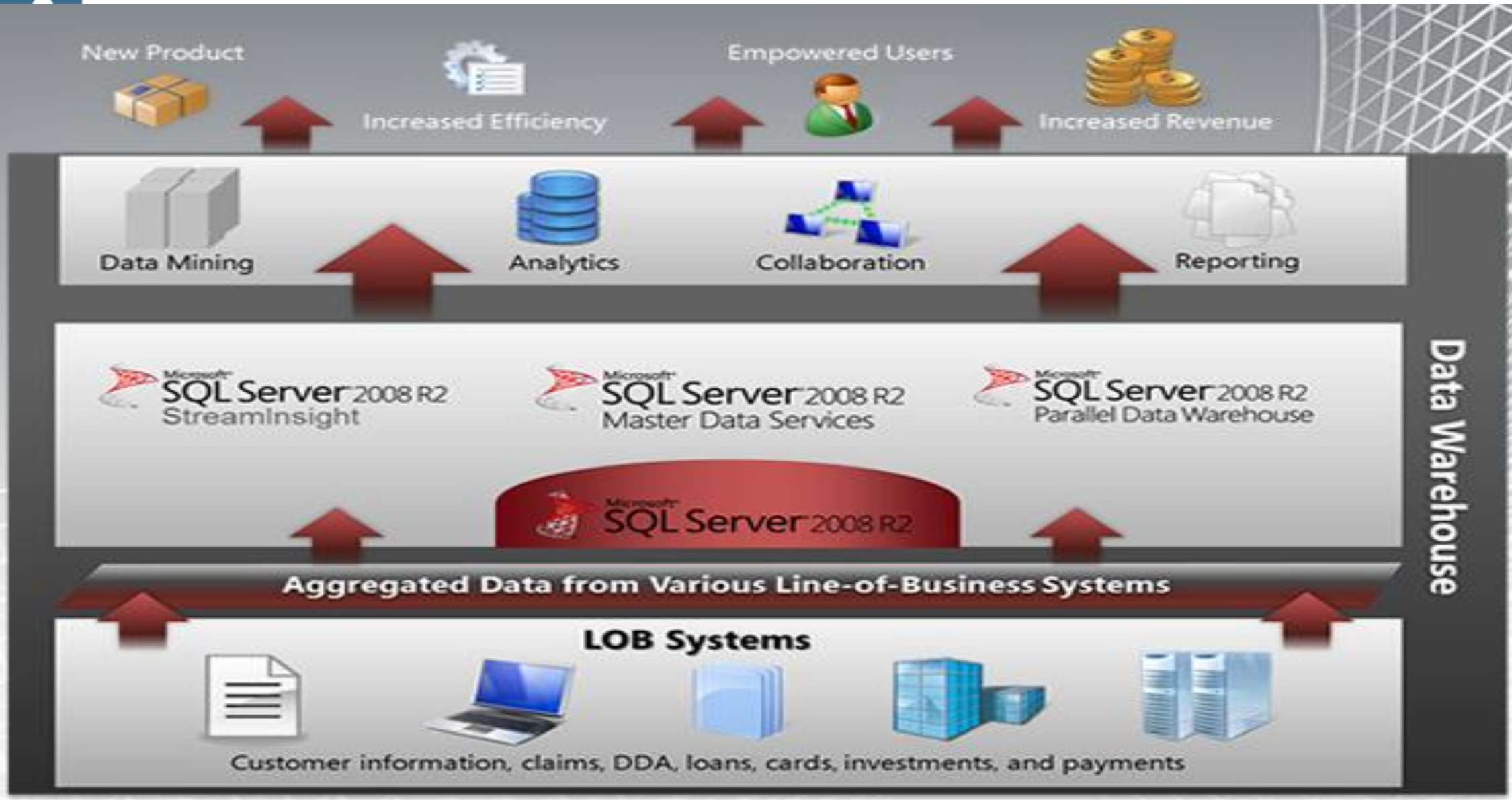
SQL Server Data Warehousing in Appliance Model

- A SQL Server appliance for DW that is:
- Scalable
  - Shared-nothing, MPP DBMS system
  - Scales from 10s to 100s of TB of data
  - Scales from ½ rack (4-6 nodes) to 4x rack (~60 nodes)
- Standards based
  - Leverages commodity hardware
  - Speaks SQL Server language (T-SQL)
- Flexible
  - Offers hardware of choice (HP/Dell)
  - Supports multiple h/w architectures
- Cost effective
  - Low price/TB ratio

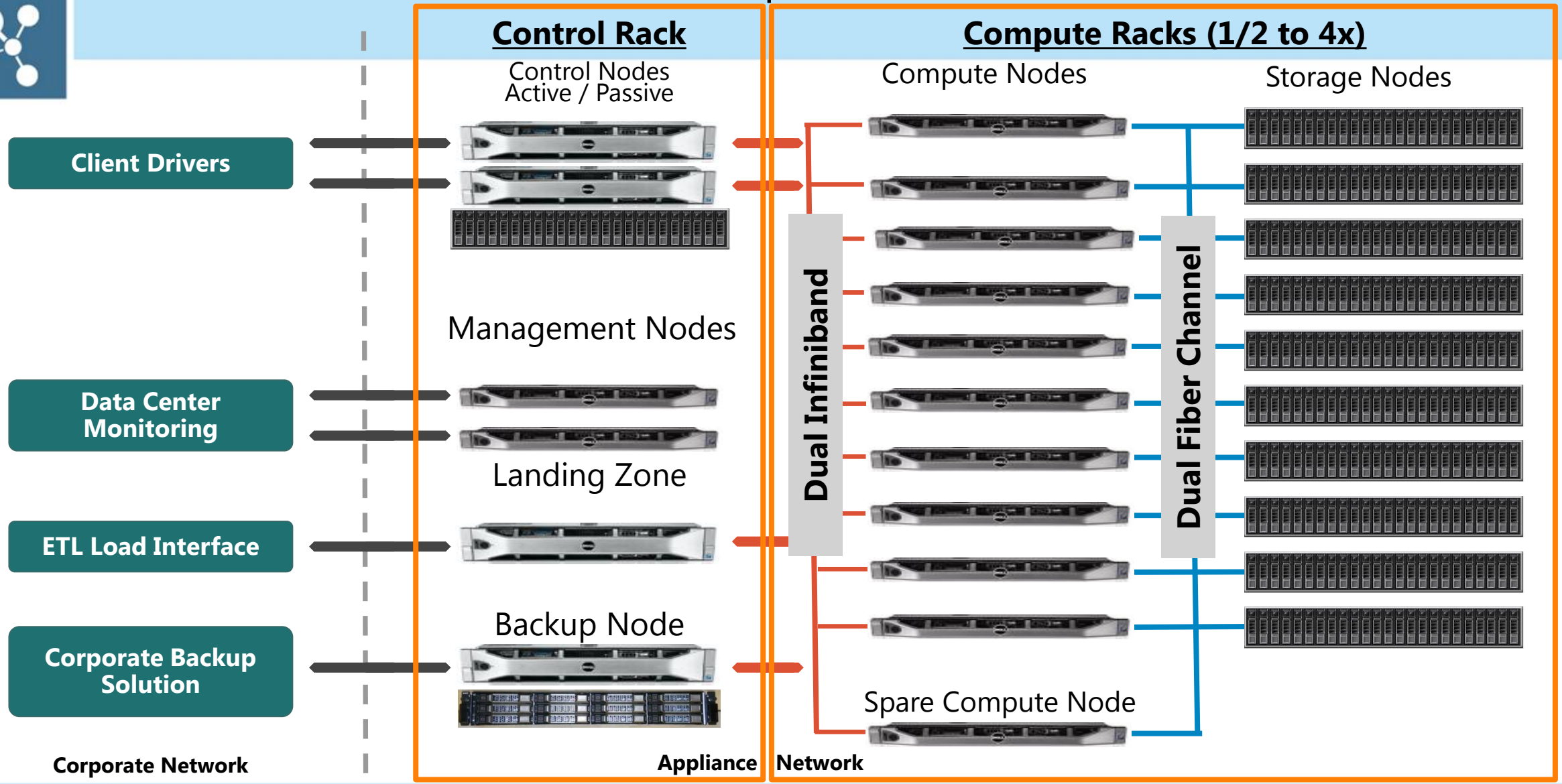


Microsoft® SQL Server® 2008 R2 Parallel Data Warehouse

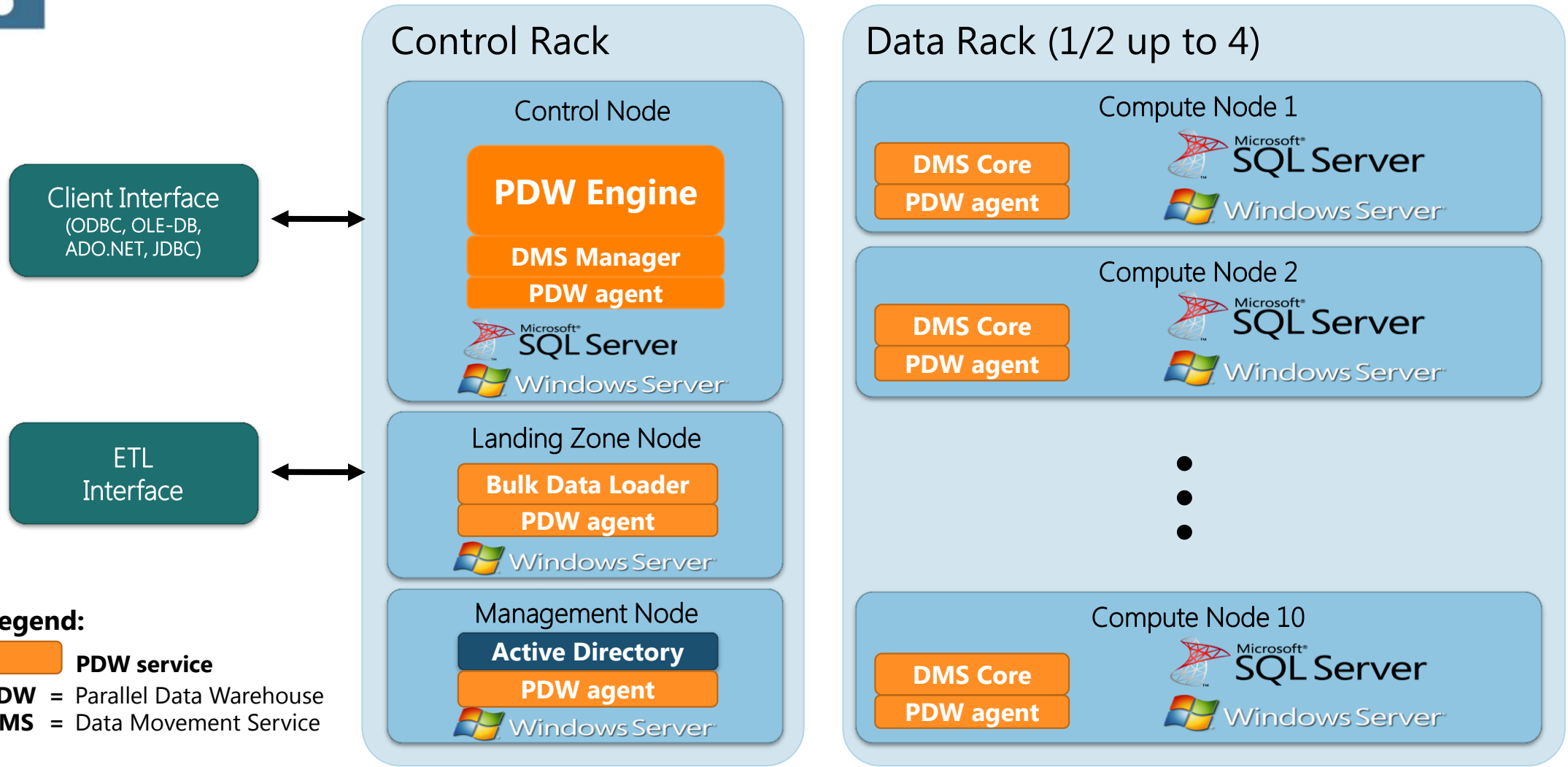
EDW Architecture



PDW Hardware Components



PDW Software Components



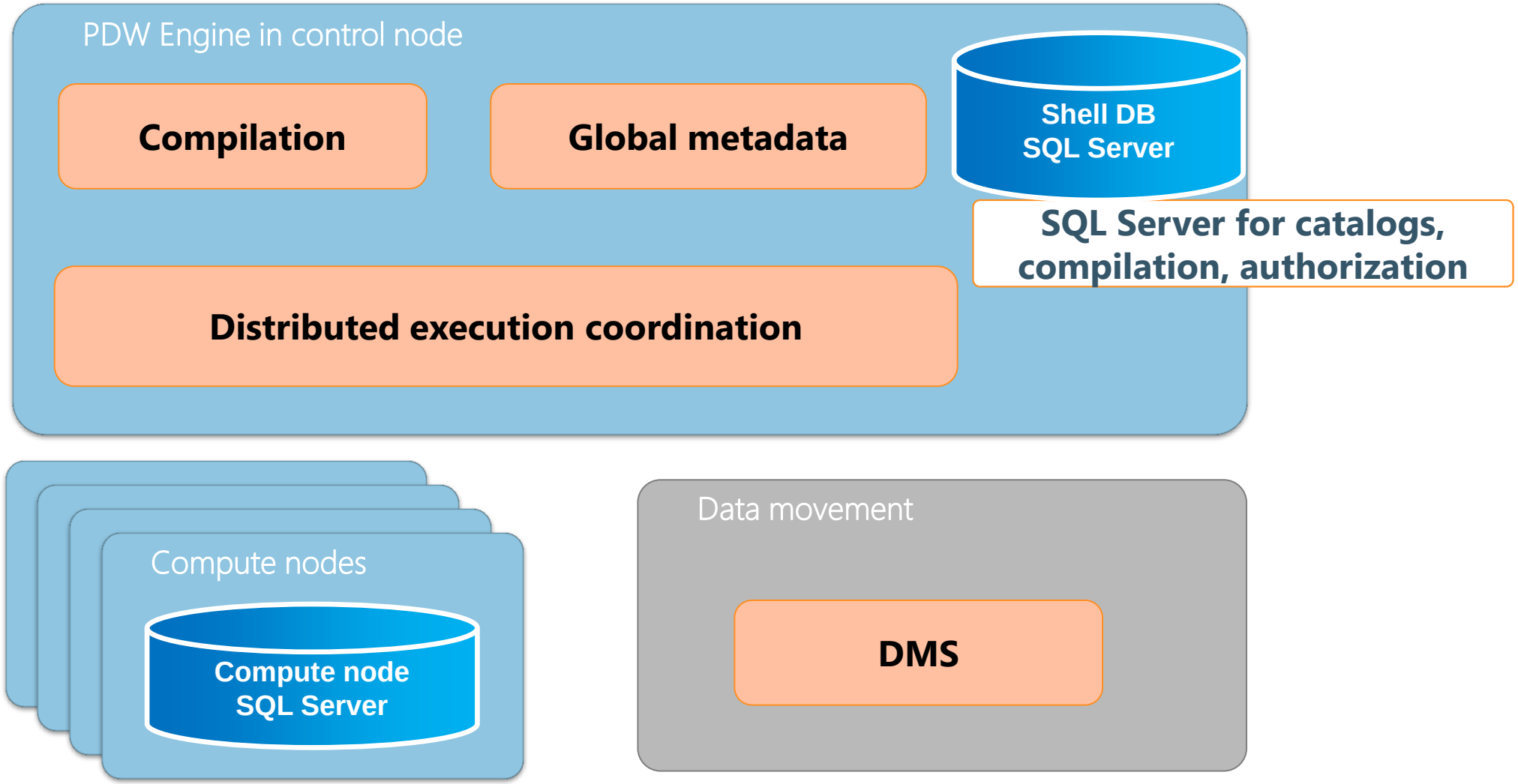
Legend:

PDW service

PDW = Parallel Data Warehouse
DMS = Data Movement Service

Shell Database and Statement Processing

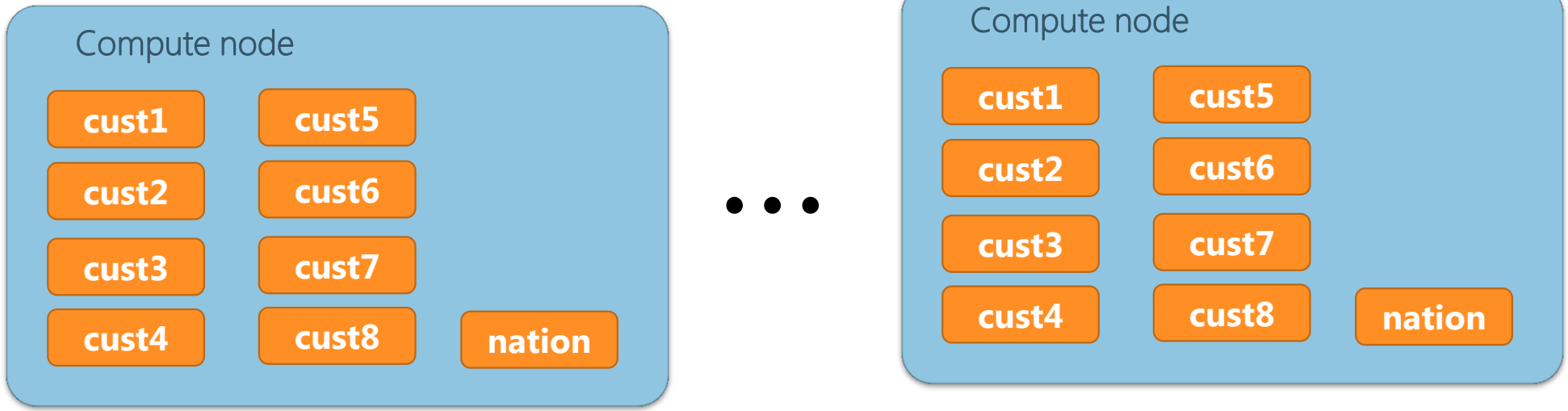
Distributed DBMS Layering



PDW Schema Design

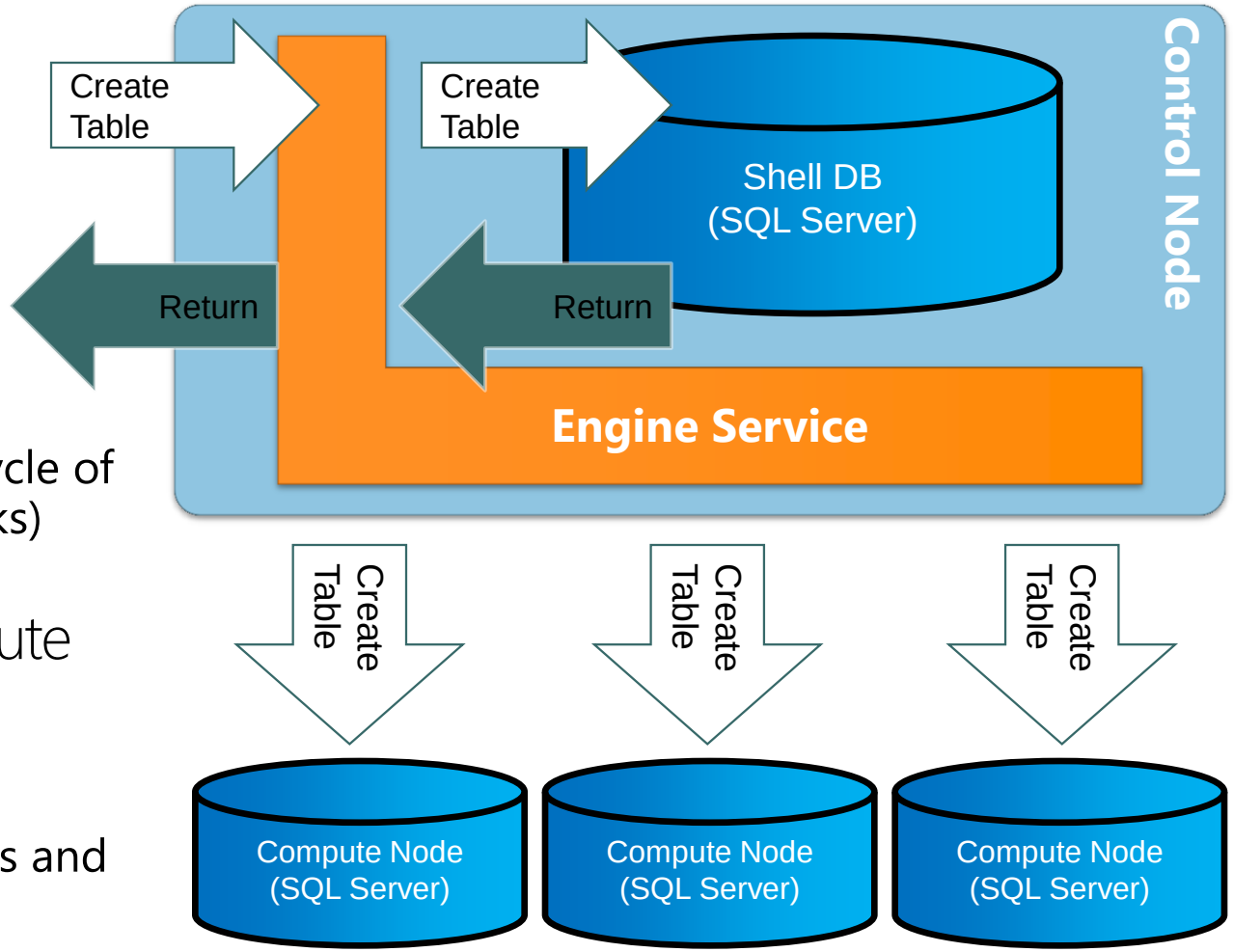
```
CREATE TABLE customer
  ( c_custkey       bigint,
    c_name          varchar(25),
    c_address       varchar(40),
    c_nationkey     int,
    c_phone         char(15),
    c_acctbal       decimal(15,2),
    c_mktsegment    char(10),
    c_comment       varchar(117))
WITH (distribution=hash(c_custkey)) ;
```

```
CREATE TABLE nation
  ( n_nationkey   int,
    n_name        varchar(25),
    n_regionkey   int,
    n_comment     varchar(117))
WITH (distribution=replicate);
```

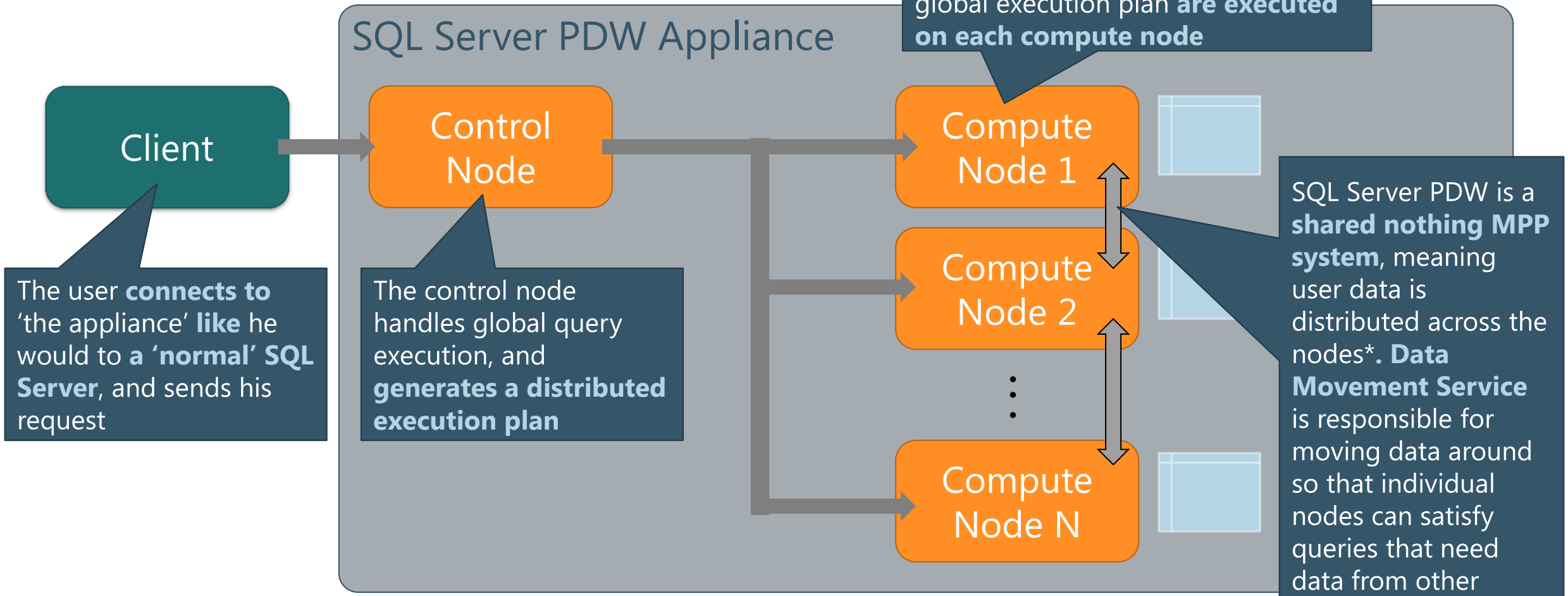


DDL Data Flow

1. User issues DDL statement
2. Statement runs on the Shell first
   - SQL Server (shell) performs the parsing, binding, authorization
   - The shell schema gets updated
   - PDW-specific info stored in extended properties
   - PDW resource manager manages life cycle of statement execution (e.g., Tx scope, locks)
3. Statement issued against the compute nodes
4. Results returned back
   - PDW rollback manager manages failures and clean-up



Quick Look at Query Execution

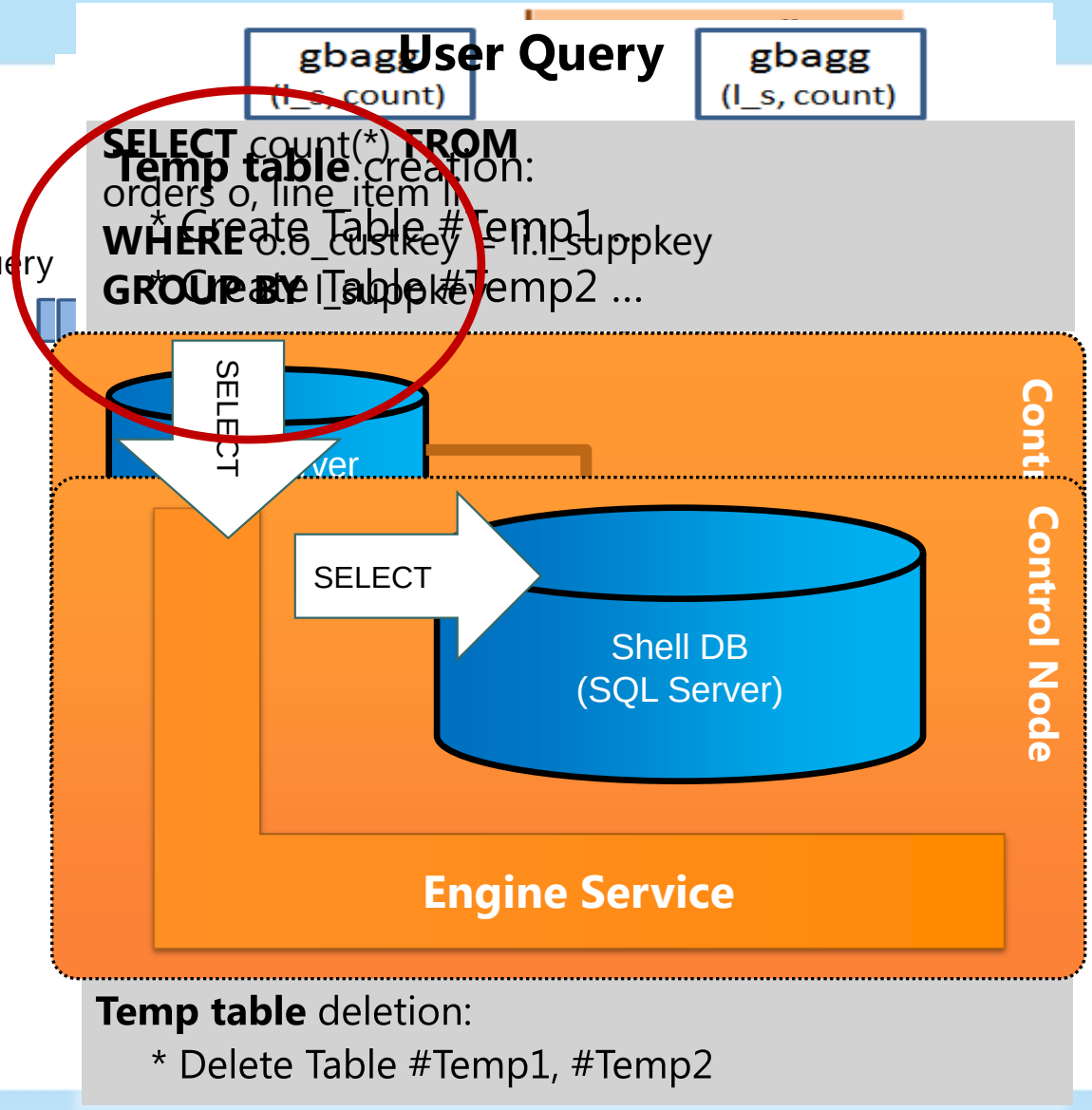


Query Optimization

1. SQL Server parsing, access validation, query simplification and exploration
   - Query simplification (e.g. column reduction, predicates push-down, subquery unnesting)
   - Logical space exploration (e.g. join re-ordering, local/global aggregation)
   - Serializing MEMO into binary XML (logical plans)
   - De-serializing binary XML into PDW Memo

2. Optimization for distributed plan (PDW)
   - Removing unnecessary plans
   - Identifying interesting properties
   - Injecting data move operations
   - Costing different alternatives
   - Pruning and selecting lowest cost distributed plan

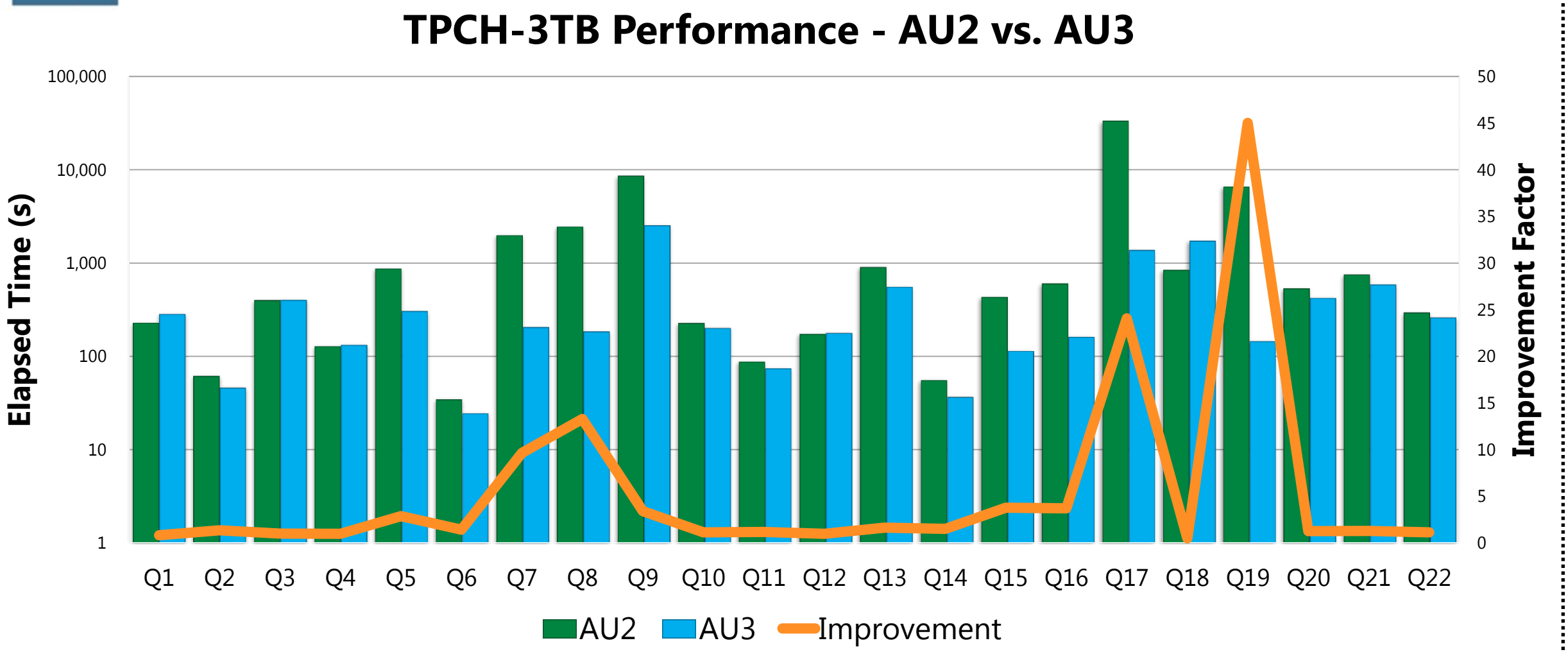
3. SQL Generation
   - Generating SQL Statements to be executed



Statistics

- Local statistics (compute nodes)
  - Standard auto-stats for user-data tables
  - Auto-stats also on temp tables created by DMS at each step
- Global statistics (Shell DB in control node)
  - Basis for distributed execution plan
  - No auto-stats (scoped out of AU3)
  - Manual stats: compute on each distribution, then merge to reflect global table

TPCH – AU3 Performance Results



Data Movement

Data Movement Primitives

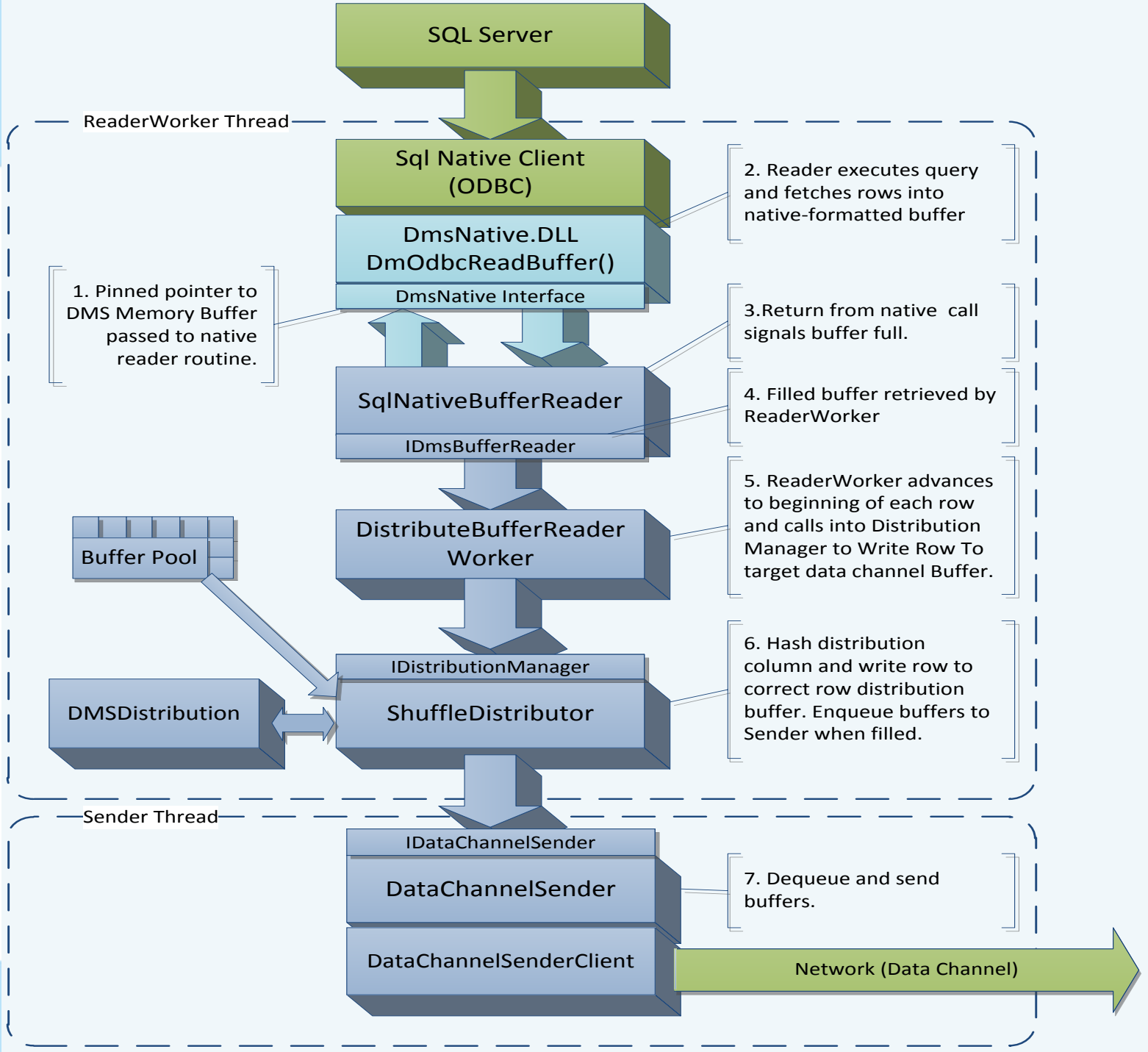
For distributed tables

- SHUFFLE_MOVE (N:N)
- BROADCAST_MOVE (N:N)
- PARTITION_MOVE (N:1)
- SHUFFLE_LOAD

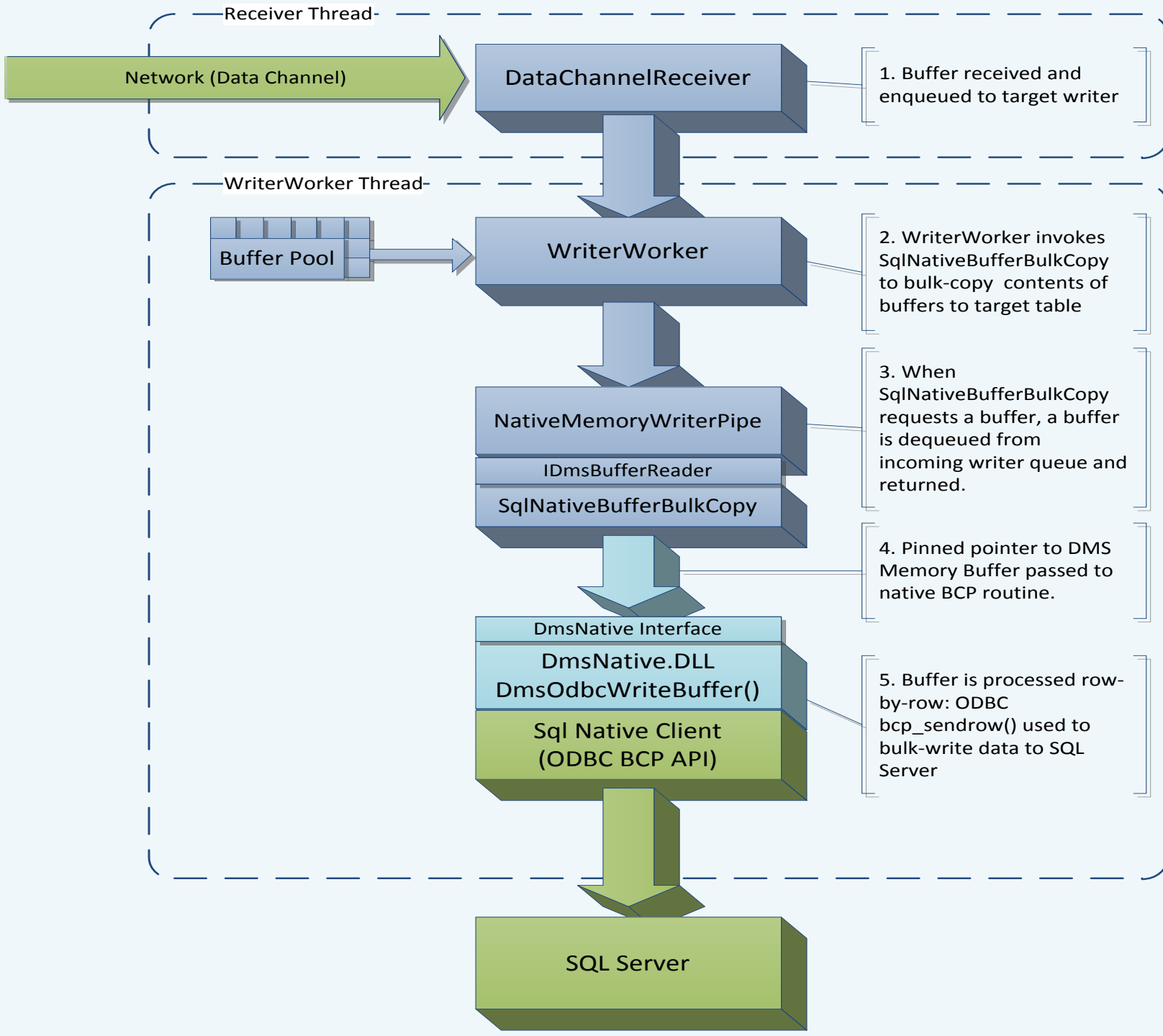
For replicated tables

- MASTER_MOVE (1:N)
- TRIM_MOVE (1:1)
- REPLICATE_MOVE (1:N)
- REPLICATE_LOAD

DMS Core Reader



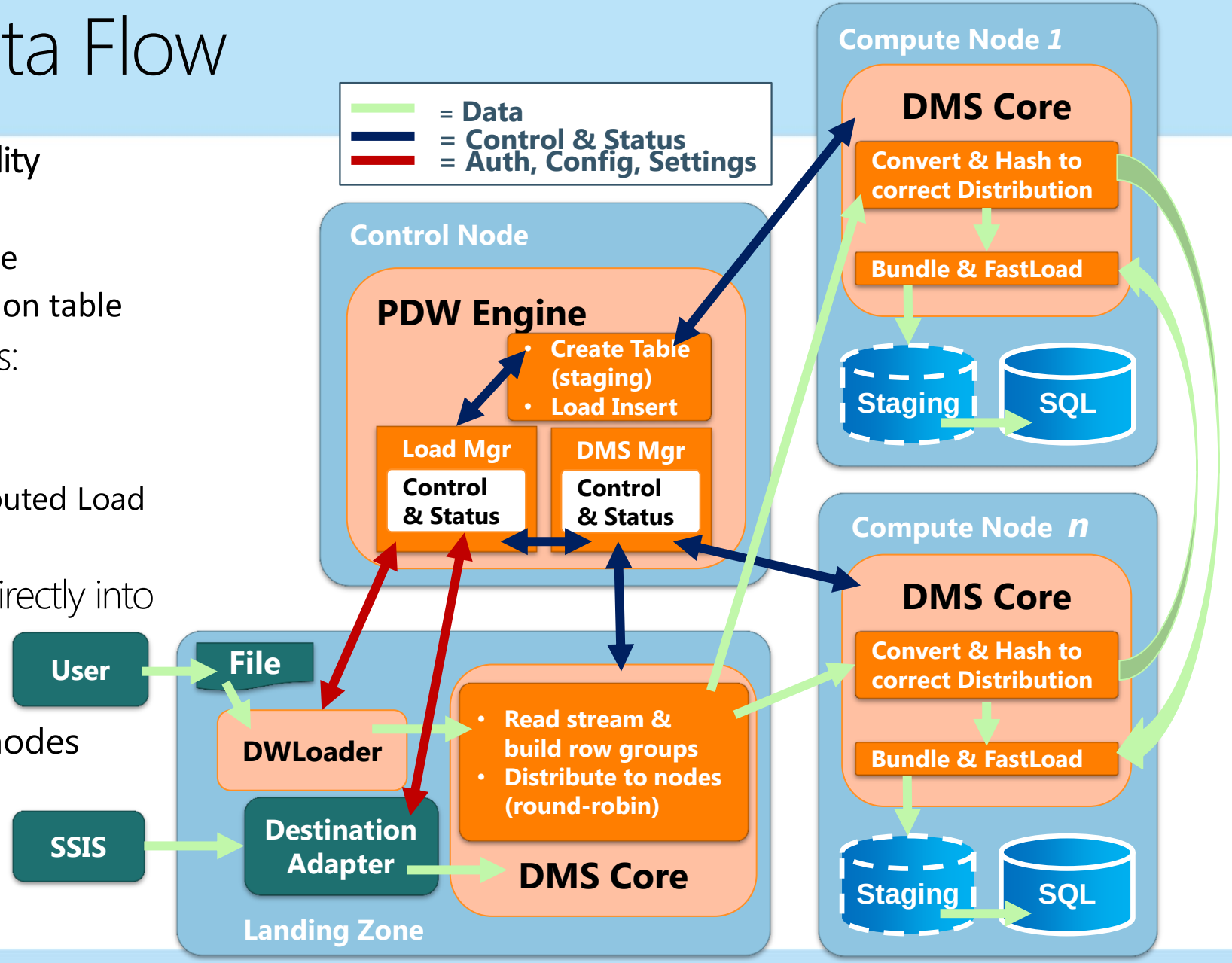
DMS Core Writer



Bulk Loading

DWLoader Data Flow

- DWLoader = bulk loading utility
  - Transactional, multi-step
  - Runs on Landing Zone Node
  - One input file per destination table
- Load is performed in 3 steps:
  - Create a staging table
  - DMS movement
    - Replicated Load & Distributed Load
  - Insert-select
- SSIS uses Adapter to load directly into DMS
- Load speed:
  - 1.2 TB/hr, 10x compute nodes
  - Target is Heap table



Other important functionality

- Backup/restore
- Fault tolerance
  - All HW components have redundancy
  - Windows Failover Cluster (WFC) for failover
  - Control, compute and management nodes have A/P
- Systems substrate
  - End-to-End setup, servicing, upgrade, replace node
  - Appliance health, monitoring, PDW SCOM Management Pack
  - PDW appliance validator
- Integration with Microsoft and 3rd party BI tools
  - SS Integration Services (ETL) has PDW as a destination
  - SS Analysis Services (OLAP) has PDW as a source
  - SS Reporting Services, Excel PowerPivot
  - SAS, Business Objects, Informatica, Microstrategy
  - Hadoop connectors (ETL)

Futures

Futures

- Column-store storage and processing
- Single-node-query optimizations
- Broader support of SQL SMP features
- Increased data load parallelism
- Hadoop integration

Summary

- PDW Fundamentals
  - Scale-out system architecture (HW and SW)
- Core functionality
  - Shell Database and Distributed Query Processing
  - Data Movement
  - Bulk Loading
- Futures

Thank you!